strate, and end caps oppositely engaging the substrate, in accordance with a preferred embodiment of the invention;

[0017] FIG. **6** is a cross-section of an actively controlled texturing system including an overlay defining surface wrinkles, a substrate adhered to the overlay, and an active material sheet disposed beneath the substrate, in accordance with a preferred embodiment of the invention;

[0018] FIG. **7** is a partial plan view of an actively controlled texturing system including a substrate, overlapping rigid members embedded therein, and shape memory arcuate actuators drivenly coupled to the members, in accordance with a preferred embodiment of the invention;

[0019] FIG. **8***a* is a plan view of an actively controlled texturing system including a reconfigurable scissor-jack fixture fixedly coupled to a substrate adhered to an overlay (not shown), and an active material element and return mechanism drivenly coupled to the fixture, in accordance with a preferred embodiment of the invention;

[0020] FIG. **8***b* is a plan view of the system shown in FIG. **8***a*, wherein the element has been activated, the fixture reconfigured, and the mechanism has been caused to store energy; and

[0021] FIG. **9** is a second embodiment of an actively controlled texturing system including a telescoping scissor-jack fixture fixedly coupled to and embedded within a substrate, and an external active material element drivenly coupled to the fixture, in accordance with a preferred embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0022] The following description of the preferred embodiments is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses. As described and illustrated herein, a novel system **10** for and method of selectively and reversibly forming wrinkles (i.e., wrinkle structures) **12** upon the entirety of a surface **14** is presented herein (FIGS. **1**-**9**). The inventive system **10** may be used to effect an intended interaction characteristic or phenomenon over a wide range of applications, including but not limited to haptic alert systems, and processes dependant upon static and/or kinematic friction. In FIG. **1**, the system **10** is shown in an automotive setting, wherein the texture of the dashboard **100** has been modified, for example, to reduce veiling glare and driver eye fatigue; and the texture of the center console **102** has been modified to reduce the contact surface area of engagement with a hot surface.

[0023] The system **10** generally includes a reconfigurable (e.g., elastic, compressible, shape recoverable, etc.) substrate **16** and a thin, high modulus overlay **18**, wherein the substrate **16** and overlay **18** present a predetermined moduli and/or Poisson's ratio relationship. The system **10** preferably further includes an active material actuator **20** that is drivenly coupled to and operable to reconfigure the substrate **16**; though it is appreciated that conventional actuators, such as solenoids and motors may be utilized. Through activation of the active material (or conventional) actuator **20** the substrate **16** is reconfigured, such that a change in lateral dimension is achieved; and by changing the lateral dimensions of the substrate **16** the overlay **18** is caused to buckle, thereby producing the targeted wrinkling effect. The wrinkling pattern may then be reversed, making a preferred material system **10** one that is sufficiently elastic to remain reversible over the desired number of cycles. Exemplary embodiments of the present invention are more particularly described below.

I. Description of Exemplary Active Materials

[0024] As used herein the term "active material" is defined as any of those materials or composites that exhibit a reversible change in fundamental (i.e., chemical or intrinsic physical) property when subjected to an activation signal. In the present invention, active materials may be used to effect reconfiguration of the substrate **16**, and may compose an actuator **20**, the substrate **16**, and/or the overlay **18** itself.

[0025] Suitable active materials for use as an actuator include but are not limited to shape memory materials that have the ability to remember their original at least one attribute such as shape, which can subsequently be recalled by applying an external stimulus. Exemplary shape memory materials include shape memory alloys (SMA), shape memory polymer (SMP), shape memory ceramics, electroactive polymers (EAP), ferromagnetic SMA's, electrorheological (ER) compositions, magnetorheological (MR) compositions, dielectric elastomers, ionic polymer metal composites (IPMC), piezoelectric polymers, piezoelectric ceramics, various combinations of the foregoing materials, and the like. With respect to the substrate, and as previously presented, SMP is particularly suitable for use.

[0026] More particularly, shape memory alloys (SMA's) generally refer to a group of metallic materials that demonstrate the ability to return to some previously defined shape or size when subjected to an appropriate thermal stimulus. Shape memory alloys are capable of undergoing phase transitions in which their yield strength, stiffness, dimension and/or shape are altered as a function of temperature. Generally, in the low temperature, or Martensite phase, shape memory alloys can be plastically deformed and upon exposure to some higher temperature will transform to an Austenite phase, or parent phase, returning to their shape prior to the deformation.

[0027] Shape memory alloys exist in several different temperature-dependent phases. The most commonly utilized of these phases are the so-called Martensite and Austenite phases. In the following discussion, the Martensite phase generally refers to the more deformable, lower temperature phase whereas the Austenite phase generally refers to the more rigid, higher temperature phase. When the shape memory alloy is in the Martensite phase and is heated, it begins to change into the Austenite phase. The temperature at which this phenomenon starts is often referred to as Austenite start temperature (A_s). The temperature at which this phenomenon is complete is called the Austenite finish temperature (A_f).

[0028] When the shape memory alloy is in the Austenite phase and is cooled, it begins to change into the Martensite phase, and the temperature at which this phenomenon starts is referred to as the Martensite start temperature (M_s). The temperature at which Austenite finishes transforming to Martensite is called the Martensite finish temperature (M_f). Generally, the shape memory alloys are softer and more easily deformable in their Martensitic phase and are harder, stiffer, and/or more rigid in the Austenitic phase. In view of the foregoing, a suitable activation signal for use with shape memory alloys is a thermal activation signal having a magnitude to cause transformations between the Martensite and Austenite phases.